TOWARDS BETTER UNDERSTANDING AND MANAGEMENT OF WATER QUALITY IN THE SACRAMENTO – SAN JOAQUIN DELTA

A Review by the

Delta Independent Science Board

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FOR DISCUSSION PURPOSES ONLY

I. Summary

This review focuses on contaminants and nutrients in the Delta, and on how findings about them have been used or neglected in various decisions related to ecosystem health in the Delta. The review considers both basic research and routine monitoring. It is based on a survey of government agencies and science programs, on interviews with water-quality specialists and users of water-quality data, and on presentations observed in workshops and conferences. The main findings, elaborated below, include:

1. It is not clear to us, or to many of the agency personnel whom we contacted, how water quality data are being used in management decisions, and whether the data being collected are sufficient to support management decisions and policies.
2. Adaptive management is rarely built into water quality programs other than those for drinking water. We recommend that more aspects of Delta water quality be managed adaptively.
3. Water quality too rarely enters into discussions about water supply and reliability. Water conveyance and storage can influence Delta water quality by affecting where, when, and how much freshwater is diverted.
4. State and federal water contractors have been the primary funders of research and monitoring to understand and protect water quality in the Delta. Will planned projects make this investment a lower priority?

GENERAL FINDINGS AND RECOMMENDATIONS:

Diverse Understandings of Water Quality

There is little that is simple, and much that can be misconstrued, in the description and interpretation of water quality in the Sacramento – San Joaquin Delta. Delta water quality means different things to different stakeholders, thus discussions of water quality often do not start from a shared understanding. Water quality is influenced, moreover, by materials from the atmosphere and the surrounding landscape, as well as by physical, chemical and biological processes in the waters themselves. An added complexity is that there is no single measure of "water quality."

Water Quality Constituents

Although the Delta is one of the most studied estuarine systems in the world, additional research is needed to support better management of chemical contaminants and nutrients.

Interactions between chemical contaminants and other stressors require more attention. This is of particular concern for the wide range of pesticides discharged into the Delta, the legacy loadings of mercury, and the natural inputs of selenium. Improved understanding of the interactive effects of multiple chemicals on the ecosystem is needed.

Studies that emphasize broad questions about nutrients, food webs, and ecosystem processes will more effectively serve management needs, compared to narrower research on nutrient forms and their ratios.

Increased emphasis is needed on the effects of nutrients on the growth of aquatic weeds and the food web of the Delta. The large-scale application of herbicides to control aquatic weeds returns nutrients to the water while also likely affecting primary productivity; such unintended impacts require more consideration.

The quality of groundwater used for drinking water requires greater attention. Agricultural pesticides and nitrates in groundwater may contribute to unsafe drinking water for some Delta residents.

Chemicals of emerging concern and harmful algal blooms will require increased vigilance and modifications of water quality monitoring and analysis programs, to protect both ecosystem health, and drinking water safety.

Monitoring and Data

There is no comprehensive contaminants monitoring and assessment program. The nascent Delta Regional Monitoring Program is a positive step, but its temporal and spatial coverage is not sufficient to satisfy the need for information. Moreover, how contaminants affect ecosystem processes needs more attention from monitoring programs.

There is a need for water-quality data monitoring at frequencies commensurate with the variability of the contaminants. This is especially so at locations where flow is measured systematically. These measurements will provide information about loadings and improve understanding of the role of key events in the delivery of contaminants to the Delta.

There is a need for improved collaboration among agencies conducting monitoring. This includes better linkages between water quality monitoring that is done for regulatory compliance, with that being done for special studies and in research programs. Likewise, there is a need for coordination of locations of water quality and biological monitoring sites

The California Water Quality Monitoring Council can play a critically important role in making monitoring data available. However, it needs additional resources in order to be more effective. There are multiple agencies that can assist in this effort.

Data management needs to be improved, especially in the area of quality assurance and quality control. While there have been positive developments in data sharing, more is needed. Increased development and use of data visualization tools should help.

II. Introduction: Overview of the ISB Review Process

A. Motivation and scope

The mandate of the Delta Independent Science Board (Delta ISB) includes reviews of science activities in support of adaptive management in the Sacramento-San Joaquin Delta. This review considers the scientific basis for assessing water quality in the Sacramento-San Joaquin Delta (the Delta, hereinafter), and on how water quality information is being used in management decisions in the Delta, especially in support of adaptive management. The review focused on:

- Water quality data and information needs by the entities responsible for the management of Delta water quality.
- Assessing the water quality parameters that are currently being monitored, and what additional parameters may be necessary.
- Assessing the temporal and spatial resolution of water quality data collection needed to understand timing, magnitude, and trends of changes in water quality.
- Evaluating the current state and utility of water quality monitoring.
- Reviewing connections between habitat quality and water quality for species of interest.
- Examining how water quality data are being used in management decisions, including the technical basis of the data being generated, the utility of the different types of data, and whether the data are sufficient to support management decisions and policies.

Motivation

A healthy Delta ecosystem requires water of good quality. However, the definition of what is "good" water quality may vary at different locations in the Delta and be dependent on how water is being used (e.g., for drinking water, agriculture, ecosystem needs). There is a perception, especially among Delta residents, that water quality is substantially impaired in the Delta and is not being considered adequately in management decisions, especially for ecosystem health. Proposed changes in water conveyance and changes in hydrology, coupled with climate change, are likely to affect water quality (e.g., Sinha et al. 2017), providing further impetus and relevance for a current review on this topic.

Water quality is a complex subject, and is closely linked to the coequal goals of providing a more reliable water supply for California and protecting and restoring the Delta ecosystem. Many agencies and groups monitor water quality, water flows, and ecological conditions in the Delta. However, even though science is increasingly telling us that 'sublethal' exposures to contaminants can profoundly affect fitness, and consequently survival and reproduction of many species (e.g., Fong et al. 2016), there is no comprehensive program that monitors and assesses contaminants in the Delta. In addition, much of the monitoring and assessment of contaminants is neither comprehensive nor coordinated.

Scope

We focused on three areas: chemical contaminants (including mercury, methylmercury, selenium, and pesticides, as well as other chemical contaminants such as pharmaceuticals, personal care products, and chemicals of emerging concern), nutrients, and drinking water constituents of concern. Concurrent with our review, the Delta Science Program convened an expert panel to specifically review the Delta Regional Monitoring Program's proposed monitoring design. This process was tracked as part of our broader review.

Water quality is defined in a variety of ways depending on the stakeholder group (e.g., for drinking water, agricultural use and ecosystem health). The Clean Water Act (CWA) established the basic structure for regulating pollutant discharges into the waters of the United States and gave EPA the authority to implement pollution control programs such as setting wastewater standards for industry (https://www.epa.gov/laws-regulations/summary-clean-water-act). In California, CWA authority is delegated to the State and Regional Boards. The Safe Drinking Water Act (SDWA) is the federal law that protects public drinking water supplies throughout the nation. Under the SDWA, EPA sets standards for drinking water quality and with its partners implements various technical and financial programs to ensure drinking water safety (https://www.epa.gov/sdwa). Our review focused primarily on the effects of chemical contaminants on ecosystem health in the Delta, but incorporated human health and well-being by also considering drinking water.

We recognize that to understand water quality and ecological processes it is important to look at many components concurrently, including: disinfection by-products, dissolved organic carbon (DOC), pH, total suspended sediment/turbidity and light penetration, and biological components such as chlorophyll, blue-green algae and cyanotoxins, and phytoplankton taxonomy and size. We evaluate how this information is integrated into existing monitoring programs.

This review did not consider salinity, temperature, or dissolved oxygen. Although the importance of these attributes as a component of overall water quality is clear, several other recent reviews have addressed salinity issues, and the science basis for both dissolved oxygen and temperature is strong already, while other aspects of water quality have not received as much attention. These aspects will be addressed in a future review by the Delta ISB.

B. The review process

Our analysis of the state of water quality science in the Delta is based on information gathered from: (1) in-person interviews with individuals involved in different aspects of water quality science in the Delta, (2) a literature review of recent publications on the topic of water quality, (3) responses to a questionnaire distributed to several agencies (Appendix X) and (4) comments from the public on a draft report. During the review process, members of the Delta ISB attended meetings of the Pelagic Organisms Decline (POD) Contaminants Work Team, the Delta Regional Monitoring Program, the Delta Nutrients Forms and Ratios Public Workshop, a University of California-Davis symposium on multiple stressors in the San Francisco Estuary, the Water Quality Monitoring Council, and a workshop on Constituents of Emerging Concern

(CECs). Members of the Delta ISB also attended relevant talks and sessions at the Bay-Delta Science Conference in 2016. Relevant papers from the recently published State of Bay Delta Science were also consulted.

A questionnaire developed by the Delta ISB was distributed to agencies/programs engaged in water quality work in the Delta. Responses to this questionnaire provided many useful insights about the state of knowledge, ongoing activities by Delta agencies/programs, and concerns. The questionnaire generated responses from twenty-three entities, representing a range of state and federal agencies involved in water quality science in the Delta. The respondents represented agencies that acquire water quality data as well as users of water quality data acquired by other agencies. The respondents included entities that use water quality data for regulatory and compliance purposes (e.g., biological opinions), as well as those that oversee water quality monitoring programs (e.g., USGS, DWR), and others driven by research. Responses to the questionnaire were diverse, and we appreciate the willingness of many people to provide a wide range of perspectives about the nature of ongoing water quality science in the Delta as well as future needs. This feedback also revealed some of the challenges associated with current efforts to monitor water quality in the Delta. The raw materials for this report are the responses, comments, and insights provided by the individuals and groups we consulted. Italicized comments below are taken verbatim from questionnaire responses or from interviews.

C. Current and future threats to water quality

Factors that affect the Delta and its water quality have been identified in a series of reports and publications (e.g., Lund et al. 2007; Mount et al. 2006, and Adams 2006, Healey et al. 2008, David et al. 2015) recent papers in San Francisco Estuary and Watershed Science (SFEWS). These reports and articles include discussions of, but are not limited to: population growth and increased urbanization; waste water inputs; agriculture and associated use of fertilizers, herbicides and pesticides; water sources and management practices; harmful algal blooms; landscape alteration; sea-level rise; and regional climate change. The availability of high quality water affects the management of endangered species, food webs, the fate of irrigation drainage, wastewater management, treatment of drinking water, and numerous other activities in the Delta and throughout California.

California's complex water management system, as well as the supplies and demands on this system, influence the quantity and quality of water in the Delta (Lund 2016). Moreover, proposed plans to build diversion tunnels that use different points of diversion than presently used (e.g., California WaterFix) and the construction of new storage and conveyance infrastructure (e.g., surface reservoir projects) could result in changes in the amount of water withdrawn and the quality of water in the Delta. These proposed changes in infrastructure and water management could have adverse effects on the Delta ecosystem (e.g., DISB 2015).

Likewise, there could be unexpected and unintended consequences from the above-mentioned actions that will affect water quality in the Delta in the future. State and federal water contractors, for example, have been primary funders of research and monitoring to understand

and protect water quality in the Delta. Depending upon the actions taken, this basis for critical information on water quality and its use in management decisions could be reduced because this investment could become a lower priority for these funders. Likewise, changes to diversion points and the potential for larger amounts of water to be withdrawn could affect Delta water quality and alter water-residence times, which would further affect water quality. These issues should be considered more carefully in discussions about, and planning for, these potential projects (Schoellhamer et al. 2016).

In addition, the anticipated effects of climate change on hydrology and water reliability have broad implications for every aspect of water and environmental management and are essential to consider in development of any plan for water quality in the future. Projections indicate trends that will result in reduced water storage from loss of snowpack, earlier runoff, larger floods, and more extreme events (Cayan et al. 2008; Cloern et al. 2011). Climate change- including sea level rise- is expected to lead to more frequent and extended periods of drought as well as more frequent and intense floods and changes in salinity (Lund 2016 and references therein). These events will influence water quality both by altering the delivery of contaminants and pathogens as well as changing the residence time of water quality constituents. Storms and floods have been shown to increase runoff of sediment, organic matter, nutrients and contaminants from land to adjacent water bodies and increase eutrophication (Sinha et al. 2017). Periods of drought lead to less dilution of contaminated point sources in receiving waters and alter water residence time, which may lead to reduced water quality in regions with poor circulation. Drought periods also affect groundwater and water quality in wells used for drinking water. The recent prolonged drought highlighted the interconnectedness of drought with these issues and implications for water quality.